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A Difficult Piece in Subaqueous Rock Excavation

By Robert G. Skerrett

SOMEONE said a while back that national preparedness should "begin at the bottom and work upward." This critic had in mind the East River, New York, and the part it would have to play in the defense of the Atlantic seaboard in time of war. He also was thinking of that vast movement of ocean-going shipping that the East River seems to invite superficially and yet hampers because of submerged obstacles. Plainly, he meant that the channel fairway should be made clear for heavy craft at least as far as the Navy Yard.

The biggest of our naval stations is situated on the Brooklyn side of the East River. There was a time when the site was admirably suited for the purpose. To-day, this is debatable, because the ships of the battle fleet have outgrown that haven or, to be exact, the one avenue of approach and departure. Unless the tide favor, the largest of our dreadnoughts cannot safely navigate the lower reach of the East River. Our fighting craft are deeper drafted than a decade back, and the existing channel is no longer a safe one at all times. This is because of a ledge of rock that reaches out from the Manhattan shore and rises in the form of a menacing hump within a trifle more than 23 feet below the surface at mean low tide. The biggest of our dreadnoughts and some of our naval colliers draw 30 feet and more when full laden, and because of subaqueous conditions these ships are not infrequently delayed in getting to and from the Navy Yard.

The principal stumbling block to free navigation at all hours is Coenties Reef. Originally, there was only 14.3 feet of water over the ledge at mean low tide, but the Government authorities cut away the rock and increased the depth 11 feet about 1875. Since then, ocean-going liners and the ships of the fighting fleet have grown apace. Time and time again Congress was urged to cut away more of the reef, but only recently have the funds been provided to strip the channel of this menace to shipping. Now, the work is under

Coenties Reef and the Whitehall-Montague St. tunnels

way, and probably before a year has gone the water over Coenties Reef at mean low tide will be not less than 40 feet. This provision will make it possible for naval craft of the deepest draft to come and go from

the Navy Yard at any time and will make it easier and safer to maneuver the big merchantmen that now dock in the lower part of the East River.

The work to be done in order to lower the reef 15 feet will involve the removal of 28,555 cubic yards of ledge rock. The Government will pay for the excavation of the first 10 feet downward and the remaining 5-foot slice will be done at the expense of New York city. Big as the undertaking is and difficult as are the conditions, the total outlay will be only \$196,900—such being the contract price; and this moderate charge is a matter of general interest, because it is the best evidence of what engineering skill has done towards facilitating the excavation of subaqueous rock. The public is probably not aware of it, but work of this sort is especially troublesome owing to uncertainties due to the very nature of the conditions involved; and in the present instance the contractor's task is made much harder because of the sweep of the currents and the fact that his drilling plant has to rest upon the slanting shoulder of the reef and to be held there firmly.

Again, the slicing off of Coenties Reef is not an ordinary case of the removal of under-water rock. The contractor cannot drill and blast as he commonly would

if dealing with the average ledge. In this instance he has to temper his operations so as not to endanger tunnel builders, and their work, who are engaged in driving two 18-foot passageways right through the same rocky mass but, of course, some distance below. It is the general practice for excavators of subaqueous rock to drill down 10 feet below the level of designed clearance. The holes so bored have a diameter of about 7 inches. These holes are spaced 10 feet apart and then charged with dynamite at the rate of approximately 4 pounds per foot of depth of penetration. Of course, the quantity of dynamite is determined by the character of the rock to be blasted. When the charge is detonated the ledge is violently wracked, and the big wide-spaced holes suffice to break up the rock so that it can be dredged away to the desired level.

In the case of Coenties Reef, the top of the
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page 247)

Sectional view showing the work of blasting away Coenties Reef over the new subway tunnels

A drill and its telescoping pipe guideway

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A Difficult Piece in Subaqueous Rock Excavation

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two tunnels will lie but 25 feet below the ultimate 40-foot plane, and it is not therefore safe for the overhead excavators to drive their drills more than four feet below that level. Neither is it judicious for them to drill large holes. As a result, the borings have a diameter of only 4 inches and are spaced every 5 feet. The dynamite charge is just about half that commonly employed. Because of these precautions the rock is broken up in smaller fragments and shattered effectually, without transmitting harmful shock to the underlying mass, through which the tunnel workers are breaking their way also with high explosive.

Owing to the delay in providing the money for the cutting down of the reef, the city tunnel builders—driving on toward Brooklyn—reached the ledge first and were well into the obstruction before the people operating from the river's surface were ready to go ahead. Coenties Reef does not cover a great area, and it was feared at first that blasting at two points would cause trouble and possibly rupture the tunnel borings unless fitted with their steel lining. This threatened to delay either one or other of the undertakings, but the experienced excavators have skilfully met this phase of the problem, and, by following after the lengthening tunnel and suiting their procedure to the novel conditions, they have been able to break away the initial layer of the ledge without hurtfully jarring either the people or the structure down in the body of the rock.

The submarine drill boat is equipped with 5 drill towers, which can be shifted from point to point along the rail. The tools are driven down to the rock inside of a telescoping pipe guideway. This guideway serves to direct the blasting charge when the drill is removed from the boring and also facilitates washing out the shaft preliminary to shoving the dynamite and its electrically-fired detonator into place. The current in the East River at times is in the neighborhood of five knots, and because of this the semi-flexible charging tube is forced aside and the lead to the hole lost. Of course, that means doing the work over again. To reduce these losses to a minimum, the tubes have been stiffened by additional straps and other means, and as the work goes on the contractors will adapt their apparatus to the trying circumstances. However, it is clear that the drill boat must be placed with a nicety over the site and held there during operations.

For this purpose, the drill craft is kept in place by four spuds or mooring posts. These are heavy affairs of timber or structural steel and are provided at their lower ends with steel points or iron shoes, which are designed either to penetrate the surface of the ledge or to secure a footing there. The spuds are disposed at the corners of the rectangular barge or boat, which carries also the steam power plant and other working mechanisms. With the spuds in position, the boat is raised bodily a few inches by means of four spud hoists or engines—one at each spud. In this manner a portion of the vessel's weight is made to bear down upon the mooring posts, and thus the plant stands, as it were upon four sturdy legs that straddle the underlying reef. It is necessary to shift this load with the changing conditions of the tide, otherwise the barge might be floated and moved, and injury done to the drills. Again, with the falling tide the boat must be lowered so that her entire weight will not be placed upon the spuds. This might strain the vessel.

The Baffling Epidemic of Infantile Paralysis

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which comes from suspension in water the child may be encouraged to make active movements himself, and to this end games are devised with the aid of those delightful expanding and floating toys made by the Japanese.

... "Will you tuck these into your coat?" said our host. "Will a duck swim?" chuckled Mr. Leaming in reply as he eagerly took the Virginia cigarettes.

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